REVIEWS AND BOOK NOTICES.

CORALS AND CORAL ISLANDS.*—This delightful book is not the work simply of a zoologist, or a physical geologist or geographer, but of one who combines to a remarkable degree the qualities of each. The book will interest and instruct not only the student in each of those departments of science, but so simple and yet so comprehensive is the author's presentation of an intricate subject that it will be pleasant reading to any one.

The names of Darwin and Dana will always be associated with the study of coral reefs, and it is pleasant to learn of the ingenuous and enthusiastic admiration with which the American speaks in the following passage of the earlier labors of the English naturalist:

"Our cruise led us partly along the course followed by Mr. Charles Darwin during the years 1831 to 1836, in the voyage of the Beagle, under Captain Fitzroy; and, where it diverged from his route, it took us over scenes, similar to his, of coral and volcanic islands. Soon after reaching Sydney, Australia, in 1839, a brief statement was found in the papers of Mr. Darwin's theory with respect to the origin of the atoll and barrier forms of reefs. The paragraph threw a flood of light over the subject and called forth feelings of peculiar satisfaction, and of gratefulness to Mr. Darwin, which still come up afresh whenever the subject of coral islands is mentioned. The Gambier Islands in the Paumotus, which gave him the key to the theory, I had not seen; but on reaching the Feejees, six months later, in 1840, I found there similar facts on a still grander scale and of more diversified character, so that I was afterwards enabled to speak of his theory as established with more positiveness than he himself, in his philosophic caution, had been ready to adopt. His work on "Coral Reefs" appeared in 1842, when my report on the subject was already in manuscript. It showed that the conclusions on other points, which we had independently reached, were for the most part the same. The principal points of difference relate to the reason for the absence of corals from some coasts, and the evidence therefrom as to changes of level, and the distribution of the oceanic regions of elevation and subsidence, topics which a wide range of travel over the Pacific brought directly and constantly to my attention." (Preface.)

* Corals and Coral Islands. By James D. Dana, LL.D. New York. Dodd & Mead, 1872. 8vo, pp. 398. With maps, plates and numerous woodcuts.

The chapters treat of "Corals and Coral Makers;" the "Structure of Coral Reefs and Islands;" the "Formation of Coral Reefs and Islands, and Causes of their Features;" the "Geographical Distribution of Coral Reefs and Islands;" the "Changes of Level in the Pacific Ocean;" and "Geological Conclusions;" with an Appendix, giving explanatory remarks on geological time, radiates, protozoans and a list of the names of species in the author's report on zoöphytes, the latter prepared by Professor Verrill.

While the first chapter gives an exhaustive and richly illustrated account of corals and coral polyps, we pass to some of the more general results of the author's studies. In speaking "a good word for coral reefs," the dread of navigators, he remarks that besides affording fishing grounds and harbors, "the wide coral banks and the enclosed channels greatly enlarge the limits tributary to the lands they encircle. Besides being barriers against the ocean, they are dikes to detain the detritus of the hills. They stop the water of the streams and cause it to drop the silt they were bearing off, and thus secure an addition to the land. They prevent, therefore, the waste which is constantly going on about islands without such barriers; for the ocean not only encroaches upon the unprotected shores of small islands, but carries off much of whatever the streams empty into it. The delta of Rewa on Viti Levu, resulting from the detritus accumulations of a large river, covers nearly sixty square miles. This is an extreme case in the Pacific, as few islands are so large and consequently rivers of such magnitude are not common. But there is rarely a coral-girt island which has not at least some narrow plains from this source; and upon them the villages of the natives are usually situated. Around Tahiti these plains are from half a mile to two or three miles in width and the cocoa-nut and bread fruit groves are mostly confined to them."

After having shown that atolls, and to a large extent other coral reefs, are registers of change of level, he shows that a large part of the Pacific Ocean must have undergone great oscillations in recent geological time. As proofs of elevation, he cites (1) "the existence on coral or other islands of patches of coral reef and deposits of shells and sand from the reefs, above the level where they are at present forming." (2) On islands not coral, the existence of sedimentary deposits, or layers of rolled stone, interstratified among the layers of igneous or other rocks constituting

the hills. "But the areas of subsidence, which covers an extent of fifty thousand square miles in the Pacific, and which commands so much interest from its bearings on geological questions, are indicated by" (1) "the existence of wide and deep channels between an island and any of its coral reefs; or in other words, the existence of barrier reefs; (2) the existence of lagoon islands or atolls; (3) the existence of submerged atolls; (4) deep bay indentations in the coasts of high islands as the terminations of valleys."

"Each atoll" says the author, "could we measure the thickness of the coral constituting it, would inform us nearly how much subsidence took place where it stands; for they are actually so many registers placed over the ocean, marking out, not only the sight [site] of a buried island, but also the depth at which it lies covered." As to the extent of the subsidence we are told—

"It is very evident that the sinking of the Society, Samoan and Hawaiian Islands has been small, compared with that required to submerge all the lands on which the Paumotus and the other Pacific atolls rest. One, two or five hundred feet, could not have buried the many peaks of these islands. Even the one thousand two hundred feet of depression at the Gambier Group is shown to be at a distance from the axis of the subsiding area. The groups of high islands above mentioned contain summits from four to fourteen thousand feet above the sea; and can we believe it possible that throughout this large area, when the two hundred islands now sunken were above the waves, there were none of them equal in altitude to the mean of these heights, or nine thousand feet? That none should have exceeded nine thousand feet in elevation is by no means probable. Hence, however moderate our estimate, there must be still allowed a sinking of many thousand feet. Moreover, whatever estimate we make that is within probable bounds, we shall not arrive at a more surprising change of level than our continents show that they have undergone; for since the Tertiary began (or the preceding period, the Cretaceous, closed) more than ten thousand feet have been added to the Rocky Mountains, and parts of the Andes, Alps and Himalayas.

Between the New Hebrides and Australia, the reefs and islands mark out another area of depression, which may have been simultaneously in progress. The long reef of one hundred and fifty miles from the north cape of New Caledonia, and the wide barrier on the west, cannot be explained without supposing a subsidence of one or two thousand feet at the least. The distant barrier of Australia is proof of great subsidence, even along the border of that continent. But the greatest amount of sinking

took place, in all probability, over the intermediate sea, called the "Coral Seas" where there are now a considerable number of atolls.

The facts surveyed give us a long insight into the past, and exhibit to us the Pacific once scattered over with lofty lands, where now there are only humble monumental atolls. Had there been no growing coral, the whole would have passed without a record. These permanent registers exhibit in enduring characters some of the oscillations which the "stable" earth has since undergone."

While the island of Ponape is cited as affording evidence of a local subsidence in progress, the downward movement is not now general, and the period during which it took place "extends back to the Tertiary era, and perhaps still further back."

Geologists and palæontologists will be grateful for the grand generalization in the final chapter entitled, "Geological Conclusions." Facts bearing in an interesting way on lithology are stated in the section on the "Formation of Limestones," where the writer concludes that the "reef-formations illustrate that not only coral conglomerates, or *coral-rag* may be made of corals, but also the very finest and most compact unfossiliferous limestones; that fine compact limestone, as flint-like in fracture as any of Silurian time, is one of the most common of coral-reef rocks and is nothing but consolidated mud, or fine sand of coral origin."

These coral-reefs, which through subsidence became in some cases at least two thousand feet thick, are happily termed "beds of limestone with living margins," the living part furnishing material for its horizontal extension outward, and also, if a slow subsidence in progress, for its increase upward. "In the case of existing coral-reefs, there is yet no evidence that the species of the lower beds differ from those of the top. There is also no evidence, in any part of any ocean, that there is a set of cold water corals fitted to commence a reef in deep water and build it up to such a level that another set of species may take it and carry it up higher; the facts thus far gathered are all opposed to such an idea. Should it be hereafter proved that the corals of the inferior beds differ in species from those now existing, it will probably be found that the predecessors of those now living were also shallow water species; so that the subsidence in any case was necessary."

We now come to the solution of some questions bearing on the theories held by perhaps the majority of naturalists, that the present ocean beds were formerly continents. So far as we are

aware Professor Dana was the first* to call attention to this popular fallacy, which gives rise to so much crude theorizing to account for the present distribution of life and land on the surface of the globe. He shows from the fact "that the sediment or débris from a shore is almost wholly thrown back by the waves against the land where it originated, or over its submerged part in the shallow waters, and that is not transported away to make deep sea formations," the important conclusion that "lands separated by a range of deep ocean cannot supply one another with material for rocks. The existence of an Atlantic ocean continent—an Atlantis—has sometimes been assumed in order to make it a source of the mud, sand, and gravel, out of which the thick sedimentary formations of the Appalachian region of North America were made. But if this Atlantis were a reality, there would still have been needed, in addition to the presence of such an ocean continent, a set of freight carriers that could beat off the waves from their accustomed work, and push aside the ordinary oceanic currents; or else Atlantis would get back all its own dirt."

Professor Dana reasons from the existence of a Jurassic coral reef in England, that the "Gulf Stream has had, from the Jurassic period in geological history onward, the same kind of influence on the temperature of the north Atlantic ocean which it now has." Before the Cretaceous period began the waters cooled somewhat, as there were no coral reefs in the British Cretaceous sea, though as late as the Miocene Tertiary, there were reef corals in the seas of northern Italy.

"The absence from the American coast of the Atlantic, of any coral reefs of the Cretaceous beds, and of any reef corals, seems to show that the oceanic temperature off this coast was not favorable for such corals; and if so, then the line of 68° F. extended at least 20° further north on the European side of the ocean than on the Atlantic — an inequality to be accounted for only by the existence of the Gulf Stream. But, in addition, the whole range of life in the European Cretaceous, and its vastly greater variety of species leave no doubt as to the higher temperature of the ocean along its European border; so that the idea of a Cretaceous Gulf Stream must be accepted, and that of a Tertiary is demonstrated by similar facts.

If the Gulf Stream had its present position and force in Oölitic, Cretaceous, and Tertiary times, then the ocean had, throughout these eras, its present extension and oceanic character; and,

*Proceedings Amer. Assoc. Adv. Science, 1856.

further, no barrier of land extended across from South America to the Canaries and Africa, dividing the South from the North Atlantic, but all was one great ocean. Such a barrier would not annul entirely the flow of the Gulf Stream; yet the North Atlantic is so small an ocean, that if left to itself its system of currents would be very feeble."

We would have liked if space allowed to reprint the whole of the section entitled "The Oceanic Coral Island Subsidence." We reproduce portions, however, for the most part in the author's own words. While he has shown that coral islands are records of slow changes of level in the ocean's bottom, they are also records of the contour of the ocean bed, as they indicate submarine linear ranges of mountains "the whole over five thousand miles in length," the whole area of subsidence being over six thousand miles in length, with a width equalling that of North America, thus forming an example of one of the "great secular movements of the earth's crust." The subsidence was in progress during the Glacial era, while the more northern continental lands, "at least those of North America," were being elevated, preparatory to, or during that era of ice: and this elevation of land northward "may have been a balance to the *downward* oceanic movements that resulted in the formation of the Pacific atolls."

There was a similar subsidence in the West Indies. "The peninsula of Florida, Cuba, and the Bahamas look, as they lie together, as if all were once part of a greater Florida, or southeastern prolongation of the continent." Professor Dana believes that a very large number of islands, more than has been supposed, lie buried in the ocean, and he cites the interesting example of the "lonely Bermuda atoll." "Its solitary state is reason for suspecting that great changes have taken place about it; for it is not natural for islands to be alone."

We quote the following paragraph, believing, that it is the key to many of the laws of geographical distribution of plants and animals, as it opposes many crude theories of the existence of former continents and continental bridges which naturalists assume to account for the present distribution of life on opposite shores of our present continents:—

"While thus seeming to prove that all the great oceans have their buried lands, we are far from establishing that these lands were oceanic continents. For as the author has elsewhere shown, the profoundest facts in the earth's history prove that the oceans

have always been oceans. These lands in all probability were, for the most part, volcanic islands or summits of volcanic ranges, for of this nature are all the islands over the interior of either ocean that are not of coral origin."

The extracts we have given, rather than any words of the reviewer, attest the clear and comprehensive manner in which the author treats of a difficult and abstruse theme. The publishers have issued the volume in a most attractive style.

MAN IN THE PAST, PRESENT AND FUTURE.*— We are assured by the modest author of these lectures that their publication was the result of "the extraordinary favor which the public has hitherto manifested towards all the literary productions of the author without exception." They seem to be a digest, with liberal quotations, of the writings of Huxley, Schaffhausen, Vogt, Haeckel and others, on man and his origin. The main facts as to the antiquity of man are given, with a chapter on his simian origin, while the future of man occupies the last third of the book. We have not been able to find that the author is an original investigator in anthropology, and with his hearty contempt for philosophy and pity for any one who believes in such infantile notions forsooth as the immortality of the soul and the existence of God, we doubt whether his superficial mode of treatment is calculated to win the regard of his readers to anthropological studies.

The crude and sophomoric style of the third chapter is more subdued in those on the antiquity and origin of man. But even here in matters of detail the author is not invariably reliable. He accepts unhesitatingly the calculation as to the age of the portions of the human skeletons found in the "coral rock" of Florida, though it has been stated in this journal (vol. ii, p. 343, Oct., 1868) by M. De Pourtales, the original discoverer of the specimens, that they were not from a coral formation, but that he took them from a "fresh water sandstone on the shore of Lake Monroe, associated with fresh water shells of species still living in the lake. No date can be assigned to the formation of that deposit at least, from present observations." It has also been questioned whether the age of the bones found in the cypress swamps of Louisiana is so

* Man in the Past, Present and Future. A popular account of the results of recent scientific research as regards the Origin, Position and Prospects of the Human Race. From the German of Dr. L. Büchner, by W. S. Dallas. London 1872. Philadelphia. J. B. Lippincott and Co. 8vo, pp. 363.